

INDIANA SECTION of the AMERICAN CHEMICAL SOCIETY

High School Scholarship Exam

April 15, 2000



1. The exam contains 100 questions. You have 2 hours and 30 minutes to complete the exam.
2. Choose the single *best* answer for each question and darken the corresponding letter on your answer sheet. The score is based on the number of correct answers- there is no penalty for incorrect guesses.
3. Calculators are permitted, but stored programs and information are not allowed.
4. You may write on this exam. The exam does not need to be returned.
5. Use of significant digits and correct units may be considered in the choice of the best answer.
6. A periodic table and a sheet of selected formulas are also provided.

- Which of the following is a physical process?
 - the rusting of iron
 - the condensation of water vapor
 - the baking of a potato
 - the formation of polyethylene from ethylene
 - the explosion of nitroglycerine
- Which is a chemical process?
 - melting of lead
 - dissolving sugar in water
 - tarnishing of silver
 - crushing of stone
- Gases and liquids share the property of:
 - compressibility
 - definite volume
 - constant composition
 - indefinite shape
- Which of the following is a pure substance?
 - concrete
 - sodium chloride
 - salt water
 - blood
- Which of the following is the highest temperature?
 - 200 °F
 - 105 °C
 - 373 K
 - none of the above
- There are a thousand _____ in a _____ .
 - micrograms, nanogram
 - kilograms, gram
 - grams, kilogram
 - micrograms, megagram
- How many times more expensive is buying a carbonated beverage in 12-oz cans at forty cents each relative to buying it in three-liter bottles at \$ 1.49 each? Note that 1.000 L = 1.057 qt and one quart contains thirty-two ounces.
 - 1.79
 - 2.27
 - 2.54
 - 2.89
 - 3.72

8. How many electrons, protons, and neutrons are in the ion ${}_{35}^{77}\text{X}^{3-}$?
- 38 electrons, 35 protons, 42 neutrons
 - 77 electrons, 32 protons, 77 neutrons
 - 32 electrons, 35 protons, 42 neutrons
 - 77 electrons, 77 protons, 35 neutrons
9. Which pair of elements below should be the most similar in chemical properties?
- C and O
 - B and As
 - I and Br
 - K and Kr
 - Cs and He
10. Which of the following molecular formulas is also the simplest (empirical) formula?
- $\text{C}_6\text{H}_6\text{O}_2$
 - $\text{C}_2\text{H}_6\text{SO}$
 - H_2O_2
 - $\text{H}_2\text{P}_4\text{O}_6$
 - C_6H_6
11. What is the formula of the compound formed between the iron (II) ion and the phosphate ion?
- FePO_4
 - Fe_2PO_4
 - $\text{Fe}_3(\text{PO}_4)_2$
 - $\text{Fe}_2(\text{PO}_4)_3$
12. Elements belonging to which group of the periodic table form ions with a 2+ charge?
- alkaline earth metals
 - halogens
 - chalcogens
 - alkali metals
 - noble gases
13. Which solution would have the highest boiling point?
- 1.50 mol of KCl in 500 mL of water
 - 1.00 mol of CaCl_2 in 500 mL of water
 - 3.00 mol of ethylene glycol, $\text{C}_2\text{H}_6\text{O}_2$, in 500 mL of water
 - pure water
 - a, b, and c have the same boiling point
14. Nitrogen and hydrogen react to form ammonia, NH_3 . How many moles of ammonia are produced by the reaction of 2.00 mol of nitrogen with 2.00 mol of hydrogen?
- 2.00 mol
 - 0.667 mol
 - 4.00 mol
 - 1.33 mol
 - 5.33 mol

15. What is the molarity of a solution that is 6.00 molal methanol (CH_3OH) in water? Assume that the volumes are additive and that the density of methanol is 0.791 g/mL.
- 4.83 M
 - 6.00 M
 - 7.59 M
 - 6.24 M
 - 3.00 M
16. What is the hybrid orbital set used by the xenon in XeF_4 ?
- sp
 - sp^2
 - sp^3
 - sp^3d
 - sp^3d^2
17. What is the shape of the molecule SF_4 ?
- tetrahedral
 - trigonal bipyramidal
 - see saw
 - octahedral
 - square pyramidal
18. What is the maximum number of electrons in an atom that have the quantum numbers:
 $n = 4, m_l = -1, m_s = +\frac{1}{2}$?
- 3
 - 4
 - 5
 - 6
 - 7
19. Which of the following is the correct formula for chloric acid?
- HCl
 - HClO_4
 - HClO_3
 - HClO_2
 - HClO
20. Which of the following polyatomic ions has a 2- charge?
- ammonium
 - carbonate
 - cyanide
 - nitrite
21. The correct name for CrCl_3 is:
- chromium trichloride
 - chromium (III) trichloride
 - chromium (III) chloride
 - chromium chlorine

22. The coefficients required to correctly balance the reaction below are
$$\text{Al}(\text{NO}_3)_3 + \text{Na}_2\text{S} \rightarrow \text{Al}_2\text{S}_3 + \text{NaNO}_3$$
- a) 2,3,1,6
 - b) 2,1,3,2
 - c) 1,1,1,1
 - d) 4,6,3,2
23. What are the products of the reaction between AgNO_3 (aq) and NaCl (aq) ?
- a) AgCl (aq) and NaNO_3 (aq)
 - b) AgCl (s) and NaNO_3 (s)
 - c) AgCl (s) and NaNO_3 (aq)
 - d) AgCl (aq) and NaNO_3 (s)
24. How many moles of oxygen are needed to react completely with 1 mole of $\text{C}_4\text{H}_8\text{O}_2$ to form CO_2 and H_2O ?
- a) 2
 - b) 3
 - c) 5
 - d) 6
25. How many grams of water are needed to prepare 500 g of a 5.00 % by mass aqueous salt solution?
- a) 25.0 g
 - b) 500 g
 - c) 475 g
 - d) 5.00 g
 - e) 495 g
26. What is the mass percentage of carbon in dimethyl sulfoxide, $\text{C}_2\text{H}_6\text{SO}$?
- a) 60.0 %
 - b) 20.6 %
 - c) 30.7 %
 - d) 25.4 %
 - e) 79.8 %
27. How many atoms of oxygen are needed to form 300 molecules of $\text{CH}_3\text{CO}_2\text{H}$?
- a) 300
 - b) 600
 - c) 3.01×10^{24}
 - d) 6.02×10^{23}
 - e) 3.61×10^{26}
28. How many molecules of CH_4O are in 32.0 g of CH_4O ?
- a) 5.32×10^{-23}
 - b) 1.00
 - c) 1.88×10^{22}
 - d) 6.02×10^{23}
 - e) 32.0

29. A compound was found to be 40.0 % carbon, 6.7 % hydrogen, and 53.3 % oxygen by weight. What is the empirical formula of the compound?
- CH₂O
 - C₂H₄O
 - C₂H₂O
 - C₂H₄O₂
 - C₃H₆O
30. A compound with an empirical formula of CH₂O was found to have a molar mass of 180 g. What is the molecular formula of the compound?
- CH₂O
 - C₄H₄O₈
 - C₈H₂₀O₄
 - C₄H₈O₄
 - C₆H₁₂O₆
31. If the reaction of 1.0 g of sulfur with 1.0 g of oxygen according to the reaction below produced 0.80 g of sulfur trioxide, what is the percent yield of sulfur trioxide?
- $$2 \text{ S} + 3 \text{ O}_2 \rightarrow 2 \text{ SO}_3$$
- 32 %
 - 296 %
 - 21 %
 - 88 %
 - 48 %
32. How many grams of SO₃ are formed by the complete reaction of 100 g S and 100 g of O₂?
- 333 g
 - 100 g
 - 200 g
 - 250 g
 - 167 g
33. Which of the following requires the least energy?
- breaking the bond between K⁺ and Cl⁻ in KCl
 - breaking the bond between H and Cl in HCl
 - separating two HBr molecules
 - separating two F₂ molecules
 - separating two H₂O molecules
34. Which of the following decreases the boiling point of a substance?
- increasing the external pressure
 - decreasing the external pressure
 - heating at a slower rate
 - heating at a constant rate

35. A helium balloon has a volume of 3.50 L at 22.0 °C and 1.14 atm. At what temperature would the balloon have a volume of 3.00 L and a pressure of 950 torr?
- 4.3 °C
 - 20.7 °C
 - 211 K
 - 41 °C
 - 273 K
36. 75.0 mL of an aqueous hydrochloric acid solution is needed to completely neutralize 55.0 mL of 1.25 M Ca(OH)₂. What is the molarity of the hydrochloric acid solution?
- 0.529 M
 - 1.06 M
 - 1.25 M
 - 0.917 M
 - 1.83 M
37. A mixture of 50.0 g of N₂ gas and 100.0 g of Cl₂ gas has a total pressure of 6.00 atm. What is the partial pressure of the nitrogen gas?
- 2.00 atm
 - 4.00 atm
 - 3.35 atm
 - 2.65 atm
 - none of the above
38. What is the density of O₂ gas in grams per liter at STP?
- 1.43 g/L
 - 0.714 g/L
 - 22.4 g/L
 - 1.00 g/L
 - 16.0 g/L
39. A solution containing 25.0 g of a nondissociating solute in 500 mL of water has a freezing point of -1.32 °C. What is the molecular weight of the solute? (K_f for water is 1.86 °C/m)
- 141 g/mol
 - 70.5 g/mol
 - 25.0 g/mol
 - 50.0 g/mol
 - 35.3 g/mol
40. Which of the following has a higher value for a 0.10 M aqueous solution of CaCl₂ than it does for pure water? I. vapor pressure II. boiling point III. freezing point
- I and II
 - I and III
 - I only
 - II only
 - III only

41. The oxide ion has the same electron configuration as:
- a) Mg^{2+}
 - b) S^{2-}
 - c) N
 - d) F
 - e) Na
42. Which of the following has the largest first ionization energy?
- a) Al
 - b) Na
 - c) Kr
 - d) Ar
 - e) Rb
43. Which of the following should have the highest melting point?
- a) $\text{C}_6\text{H}_{12}\text{O}_6$
 - b) NaCl
 - c) H_2O
 - d) MgO
 - e) HCl
44. Gaseous iodine pentafluoride can be prepared by the reaction of solid I_2 and gaseous fluorine:
 $\text{I}_2(\text{s}) + 5 \text{F}_2(\text{g}) \rightarrow 2 \text{IF}_5(\text{g})$. A 5.00 L flask is charged with 2.50 mol of F_2 and 1.00 mol of I_2 . The reaction proceeds until one of the reactants is completely consumed. After the reaction the temperature in the flask is 125°C . What is the mass in the flask after the reaction?
- a) 222 g
 - b) 444 g
 - c) 666 g
 - d) 349 g
45. What is the oxidation state of manganese in the permanganate ion (MnO_4^-)?
- a) -1
 - b) +2
 - c) +4
 - d) +7
 - e) +8
46. Which of the following molecules has a dipole moment of zero?
- a) CO_2
 - b) H_2O
 - c) NH_3
 - d) COH_2
 - e) HCl

47. In the following reaction, what species is being reduced?
 $\text{Zn (s)} + 2 \text{HCl (aq)} \rightarrow \text{ZnCl}_2 \text{(aq)} + \text{H}_2 \text{(g)}$
- Zn
 - H
 - Cl
 - H^+
 - Cl^-
48. Consider the following reaction:
 $2 \text{N}_2 \text{(g)} + \text{O}_2 \text{(g)} \rightarrow 2 \text{N}_2\text{O (g)} \quad \Delta\text{H} = +163.2 \text{ kJ}$
How much heat is transferred when 25.0 g of N_2O forms by this reaction at constant temperature?
- 92.7 kJ
 - 46.4 kJ
 - 4080 kJ
 - 2040 kJ
49. When a 6.50 g sample of solid sodium hydroxide dissolves in 100.0 g of water in a coffee-cup calorimeter, the temperature rises from 21.6°C to 37.8°C . Calculate ΔH (in kJ/mol) for the solution process: $\text{NaOH (s)} \rightarrow \text{Na}^+ \text{(aq)} + \text{OH}^- \text{(aq)}$. Assume that the specific heat of the solution is the same as that of pure water ($4.18 \frac{\text{J}}{\text{g}\cdot\text{K}}$).
- 7.21 kJ/mol
 - + 44.4 kJ/mol
 - + 7.21 kJ/mol
 - 44.4 kJ/mol
 - + 6.77 kJ/mol
50. Which of the following statements is false:
- metals have a shiny luster
 - metals are good conductors of heat and electricity
 - most metal oxides are ionic solids that are basic
 - metals tend to have low ionization energies
 - metals typically form anions in aqueous solution
51. The molecule of ethylene, C_2H_4 , contains _____ sigma bond(s) and _____ pi bond(s).
- 1, 1
 - 1, 5
 - 5, 1
 - 4, 2
 - 2, 4
52. Consider the phase diagram for carbon dioxide shown at right. What phase change does solid CO_2 undergo as it is heated at a constant pressure of 1 atm?

- a) fusion
- b) crystallization
- c) vaporization
- d) condensation
- e) sublimation

53. What type of crystalline unit cell is displayed by NaCl (s) ?

- a) primitive cubic
- b) face centered cubic
- c) body centered cubic
- d) orthorhombic
- e) none of the above

54. Arrange these atoms and ions in order of increasing size: Ar, Cl⁻, S²⁻, K, K⁺

- a) Ar, Cl⁻, S²⁻, K⁺, K
- b) K, S²⁻, Cl⁻, Ar, K⁺
- c) K⁺, Ar, Cl⁻, S²⁻, K
- d) K⁺, K, Ar, Cl⁻, S²⁻
- e) K, Ar, K⁺, Cl⁻, S²⁻

55. Of all the halogens, _____ has the highest ionization energy and the most exothermic electron affinity.

- a) fluorine
- b) chlorine
- c) bromine
- d) iodine

56. An example of a covalent-network solid is:

- a) salt
- b) glucose (C₆H₁₂O₆)
- c) quartz
- d) water
- e) salt water

57. Molecular orbital theory describes the respective bond orders in H₂, H₂⁺, and H₂⁻ as:

- a) 1, 0, and 0
- b) 1, 1/2, and 0
- c) 1, 0, and 1/2
- d) 1, 1/2, and 1/2
- e) 1, 2, and 0

58. Excited lithium atoms emit visible light that has photons of energy 2.96×10^{-19} J. Calculate the wavelength of the light that is emitted by the excited lithium atoms.

- a) $8.4 \times 10^3 \text{ m}$
- b) $1.01 \times 10^{27} \text{ m}$
- c) $6.72 \times 10^{-7} \text{ m}$
- d) $2.24 \times 10^{-19} \text{ m}$
- e) $6.72 \times 10^{-6} \text{ m}$

59. Which of the following gases, under identical conditions, moves the most slowly: He, Ne, Ar, or Kr ?

- a) He
- b) Ne
- c) Ar
- d) Kr
- e) they all have the same velocity because they are at the same T and P

60. Consider the following standard enthalpies of formation at 298 K:

<u>Substance</u>	<u>ΔH_f° (kJ/mol)</u>
IF (g)	- 95
IF ₅ (g)	- 840
IF ₇ (g)	- 941
I ₂ (g)	+ 62

Calculate the value of ΔH° for the reaction at 298 K: $\text{IF}_7(\text{g}) + \text{I}_2(\text{g}) \rightarrow \text{IF}_5(\text{g}) + 2 \text{IF}(\text{g})$.

- a) + 151 kJ
- b) + 56 kJ
- c) - 1814 kJ
- d) - 151 kJ

61. What is the molarity of a solution that is made by dissolving 2.5 g of sodium chloride (NaCl) in enough water to make 100 mL of solution?

- a) 0.43 M
- b) 2.5 M
- c) 0.25 M
- d) 4.3 M

62. Consider the correct Lewis structure of IF_4^- . Identify the number of lone pairs of electrons, if any, that the iodine has in its valence shell.

- a) zero
- b) one
- c) two
- d) three
- e) four

63. Which of the following is the formula for sulfuric acid?

- a) HSO_4

- b) HSO₃
- c) H₂S
- d) H₂SO₄
- e) H₂SO₃

64. What type of covalent bond is the longest?

- a) single
- b) double
- c) triple
- d) they are all the same length

65. Hydrogen and nitrogen react to form ammonia, NH₃: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$. How many liters of ammonia can be formed by reaction of 3.00 moles of hydrogen and excess nitrogen? The reaction mixture is held at 27 °C and 1 atm pressure.

- a) 44.6 L
- b) 139 L
- c) 4.43 L
- d) 73.9 L
- e) 49.3 L

66. How many significant figures are in the number 0.0670 ?

- a) one
- b) two
- c) three
- d) four
- e) five

67. During the combustion of 5.00 g of ethanol, C₂H₅OH, 35.3 kcal is released. The reaction is: $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$. How much energy is released by combustion of 1.00 mole of ethanol?

- a) 35.3 kcal
- b) 7.06 kcal
- c) 325 kcal
- d) 177 kcal

68. Consider the following equilibrium reaction: $2\text{F}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{OF}_2(\text{g})$. In which direction would the equilibrium shift if F₂(g) is added to the reaction mixture?

- a) left
- b) right
- c) both of the above
- d) none of the above

69. Which family on the periodic table forms diatomic molecules in the natural state?

- a) alkali metals
- b) alkaline earth metals

- c) halogens
 - d) noble gases
 - e) transition metals
70. Members of what class of elements on the periodic table have the ability to form cations with different charges by losing different numbers of electrons from atoms of the same element?
- a) alkali metals
 - b) alkaline earth metals
 - c) halogens
 - d) noble gases
 - e) transition metals
71. Consider the electron configuration of the ground state nitrogen atom. How many half filled orbitals does this atom have?
- a) 1
 - b) 2
 - c) 3
 - d) 4
 - e) 5
72. In which of the following would London dispersion forces be the predominant intermolecular force?
- a) CaCl_2
 - b) H_2O
 - c) Br_2
 - d) HBr
 - e) $\text{CH}_3\text{-OH}$
73. When heat is absorbed over the course of a chemical reaction, this means:
- a) ΔH is negative
 - b) ΔH is positive
 - c) ΔG is negative
 - d) ΔG is positive
 - e) ΔS is negative
74. What element, in its ground state, has its first, second, and third shells filled, with five electrons in the fourth shell?
- a) bromine
 - b) arsenic
 - c) manganese
 - d) vanadium
 - e) none of the above
75. The density of chloroform is 1.47 g/mL. How many milliliters would you need to measure out to obtain a mass of 25.0 grams?
- a) 17.0 mL
 - b) 36.8 mL
 - c) 0.60 mL

d) 25.0 mL

76. Which of the following is the correct name for N_2O_3 ?

- a) nitrogen (III) oxide
- b) nitrogen (II) oxide
- b) dinitrogen oxide
- c) nitrogen trioxide
- e) dinitrogen trioxide

77. One milliliter of 5.0 M hydrochloric acid was diluted with water to a final volume of 1.5 L. What is the molarity of this solution?

- a) 3.3×10^{-2} M
- b) 7.5 M
- c) 3.3 M
- d) 3.3×10^{-3} M

78. Consider the following change: $\text{Br}_2(\text{l}) + \text{heat} \rightarrow \text{Br}_2(\text{g})$. What is the name of this phase change?

- a) melting
- b) vaporization
- c) crystallization
- d) sublimation
- e) condensation

79. What are the approximate bond angles in a molecule of CH_4 ?

- a) 180°
- b) 120°
- c) 109°
- d) 90°
- e) none of the above

80. Which family of elements has a full valence shell?

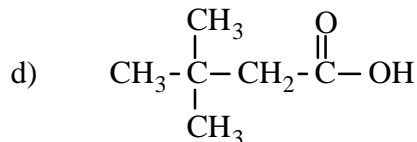
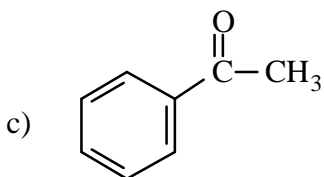
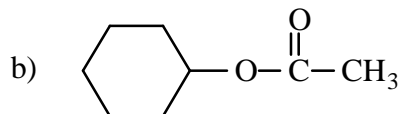
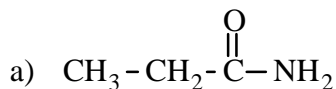
- a) alkali metals
- b) alkaline earth metals
- c) halogens
- d) noble gases
- e) all of the above

81. Which of the following is an example of a Bronsted-Lowry acid-base reaction?

- a) $\text{H}_2\text{CO}_3(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$
- b) $2 \text{H}_3\text{PO}_4(\text{aq}) + 3 \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow 6 \text{H}_2\text{O}(\text{l}) + \text{Ba}_3(\text{PO}_4)_2(\text{s})$
- c) $6 \text{HCl}(\text{aq}) + 2 \text{Al}(\text{s}) \rightarrow 2 \text{AlCl}_3(\text{aq}) + 3 \text{H}_2(\text{g})$
- d) $\text{FeCl}_3(\text{aq}) + \text{KOH} \rightarrow \text{Fe}(\text{OH})_3(\text{s}) + 3 \text{KCl}(\text{aq})$

- a) 3,3,5,7-quatramethylnonane
- b) 2-ethyl-4,6,6-trimethyloctane
- c) 3,5,7,7-tetramethylnonane
- d) 3,3,5-methyl-ethyloctane
- e) 3,3,5,7-tetramethylnonane

87. Which compound below contains an ester functional group?



88. What is the pH of a 0.010 M solution of acetic acid, $\text{HC}_2\text{H}_3\text{O}_2$?
The K_a of acetic acid is 1.8×10^{-5} .

- a) 0.010
- b) 6.74
- c) 4.24
- d) 3.37
- e) 2.00

89. A 100.0 mL sample of 0.10 M acetic acid is mixed with 100.0 mL of 0.10 M sodium hydroxide at 25 °C. What is the pH of the resultant solution? The K_a of acetic acid is 1.8×10^{-5} .

- a) 8.72
- b) 7.00
- c) 10.98
- d) 5.28
- e) 8.87

90. A buffer solution is prepared by dissolving 8.00 g of sodium acetate ($\text{NaC}_2\text{H}_3\text{O}_2$) in 250.0 mL of 0.50 M acetic acid. Assume no volume change occurs upon dissolution. What is the pH of this buffer solution? The K_a of acetic acid is 1.8×10^{-5} .

- a) 4.74
- b) 4.63
- c) 4.85
- d) 2.52
- e) 8.00

91. Phenolphthalein is a widely used indicator in acid-base titrations. Identify which best describes the color change observed:

- a) colorless in acidic solution; pink in basic solution
- b) pink in acidic solution; colorless in basic solution
- c) red in acidic solution; yellow in basic solution
- d) yellow in basic solution; red in acidic solution
- e) red in acidic solution; blue in basic solution

92. You need to add exactly 10.00 mL of reagent X to your reaction mixture. Which of the following would be the most accurate glassware for this transfer?
- 10-mL graduated cylinder
 - 50-mL graduated beaker
 - 50-mL buret
 - 10-mL pipet
 - 50-mL graduated Erlenmeyer flask
93. The K_{sp} for CaF_2 is 3.9×10^{-11} at 25°C . What is the solubility of CaF_2 in water in grams per liter at 25°C ?
- 1.7×10^{-2}
 - 2.1×10^{-4}
 - 3.9×10^{-3}
 - 3.4×10^{-4}
 - 2.7×10^{-2}
94. A solution contains $2.0 \times 10^{-3} \text{ M Pb}^{2+}(\text{aq})$. Solid sodium iodide (NaI) is added to the solution. What is the concentration (in molarity) of I^- needed to begin precipitation? Assume that no volume change occurs when the $\text{NaI}(\text{s})$ is added to the solution. The K_{sp} of PbI_2 is 1.4×10^{-8} .
- PbI_2 will not precipitate under these conditions
 - 7.0×10^{-6}
 - 1.3×10^{-3}
 - 1.4×10^{-8}
 - 2.6×10^{-3}
95. Write the complete and balanced equation for the following oxidation-reduction reaction that occurs in acidic solution: $\text{Mn}^{2+}(\text{aq}) + \text{BiO}_3^-(\text{aq}) \rightarrow \text{Bi}^{3+}(\text{aq}) + \text{MnO}_4^-(\text{aq})$
- $\text{H}_2\text{O}(\text{l}) + \text{Mn}^{2+}(\text{aq}) + \text{BiO}_3^-(\text{aq}) \rightarrow \text{MnO}_4^-(\text{aq}) + \text{Bi}^{3+}(\text{aq}) + 2 \text{H}^+(\text{l})$
 - $2 \text{Mn}^{2+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{aq}) + 5 \text{BiO}_3^-(\text{aq}) \rightarrow 2 \text{MnO}_4^-(\text{aq}) + 5 \text{Bi}^{3+}(\text{aq}) + 14 \text{OH}^-(\text{l})$
 - $2 \text{Mn}^{2+}(\text{aq}) + 14 \text{H}^+(\text{aq}) + 5 \text{BiO}_3^-(\text{aq}) \rightarrow 2 \text{MnO}_4^-(\text{aq}) + 5 \text{Bi}^{3+}(\text{aq}) + 7 \text{H}_2\text{O}(\text{l})$
 - $2 \text{OH}^-(\text{aq}) + \text{Mn}^{2+}(\text{aq}) + \text{BiO}_3^-(\text{aq}) \rightarrow \text{MnO}_4^-(\text{aq}) + \text{Bi}^{3+}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
96. A $\text{Cr}^{3+}(\text{aq})$ solution is electrolyzed using a current of 13.5 A. What mass of $\text{Cr}(\text{s})$ is plated out after 1000 minutes?
- 145 g
 - 2.42 g
 - 435 g
 - 2.79 g
 - 1450 g

The standard Gibbs energy change for the decomposition of N_2O_4 at 298 K is 4.3 kJ/mole. Calculate the concentration of NO_2 (g) in a closed container containing an equilibrium concentration of 0.250 M N_2O_4 (g). The balanced equation for the decomposition of N_2O_4 is: N_2O_4 (g) \rightarrow 2 NO_2 (g)

- a) 0.50 M
- b) 0.21 M
- c) 1.2 M
- d) 0.044 M

99. The decomposition of sulfuryl chloride (SO_2Cl_2) is a first order reaction with a half life of 3.15×10^4 s. Calculate the concentration of sulfuryl chloride remaining in a reaction container after 5.00 hours of decomposition of an initial concentration of 0.0248 M of sulfuryl chloride.

- a) 0.0167 M
- b) 0.0124 M
- c) 0.121 M
- d) 0.0143 M

100. The reaction N_2 (g) + 3 H_2 (g) \rightarrow 2 NH_3 (g) is spontaneous at room temperature, but becomes nonspontaneous at much higher temperatures. For this reaction:

- a) $\Delta\text{H} < 0$ and $\Delta\text{S} < 0$
- b) $\Delta\text{H} < 0$ and $\Delta\text{S} > 0$
- c) $\Delta\text{H} > 0$ and $\Delta\text{S} < 0$
- d) $\Delta\text{H} > 0$ and $\Delta\text{S} > 0$

INDIANA SECTION of the AMERICAN CHEMICAL SOCIETY

High School Scholarship Exam Answer Key

April 15, 2000



1. b	21. c	41. a	61. a	81. b
2. c	22. a	42. d	62. c	82. b
3. d	23. c	43. d	63. d	83. a
4. b	24. c	44. d	64. a	84. c
5. b	25. c	45. d	65. e	85. e
6. c	26. c	46. a	66. c	86. e
7. b	27. b	47. d	67. c	87. b
8. a	28. d	48. b	68. b	88. d
9. c	29. a	49. d	69. c	89. a
10. b	30. e	50. e	70. e	90. b
11. c	31. e	51. c	71. c	91. a
12. a	32. e	52. e	72. c	92. d
13. e	33. d	53. b	73. b	93. a
14. d	34. b	54. c	74. b	94. e
15. a	35. a	55. a	75. a	95. c
16. e	36. e	56. c	76. e	96. a
17. c	37. c	57. d	77. d	97. c
18. a	38. a	58. c	78. b	98. b
19. c	39. b	59. d	79. c	99. a
20. b	40. d	60. d	80. d	100. a